Digital in-line holographic microscopy of biological samples

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With the newly constructed free electron lasers, powerful x-ray sources which provide only femtosecond pulse length and high peak intensities become available. To fully exploit the great potential these new sources offer, coherent imaging techniques are desired. Digital in-line soft X-ray holography (DIXH) is such a lensless microscopy technique which we use to investigate biological samples. The experimental setup follows directly the initial idea of Gabor to achieve a magnification of small objects via a holographic projection microscope based on a strongly divergent photon beam. We create such light cones by tailored pinholes and achieve high lateral resolution without any optical elements such as zone plates. To provide a stable and drift free scattering geometry, the new scattering chamber HORST was constructed. This setup can be used for holographic imaging and diffraction microscopy at synchrotron sources and free electron lasers. By tuning the x-ray energy to core resonances, element specific contrast can be obtained. Applications in the field of life sciences and biofouling will be discussed and results obtained at synchrotrons and the free electron laser FLASH will be shown. To fully exploit the three-dimensionality of soft x-ray holography remains a challenge, thus this facet of the technique will be illustrated by our recent work on tracking of microorganisms in the vicinity of surfaces with visible laser light. To understand exploration and settlement behavior is important in biofouling research as it informs the development of environmentally benign coatings for marine applications.